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COMMAND, CONTROL AND INTEGRATION OF WEAPONIZED UNMANNED AIRCRAFT INTO THE AIR-TO-GROUND SYSTEM

by

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Chapter 1

Introduction

The advent of unmanned aerial vehicles (UAVs) has changed the nature of warfare. Their persistence, economy, and utility have made them indispensable on the battlefield. What started as an Advanced Concept Technology Demonstration (ACTD) in 1994 with the UAV that became the RQ-1 Predator has evolved into the armed-Predator (MQ-1), with more weaponized UAVs on the way.[1] Soon the United States (US) Army will field the extended-range/multi-purpose (ER/MP) Warrior unmanned aircraft system (UAS) and the US Air Force (USAF) will field the MQ-9 Reaper, both weaponized and lethal. As UAVs evolved from the Intelligence, Surveillance and Reconnaissance (ISR)-only platform to one that can find, fix and target, much debate has emerged over their best employment.

The lines blurred between the ISR and ground attack mission when the first AGM-114 Hellfire Missile was test-fired from a Predator in February 2001.[2] In her article "Clash of the UAV Tribes", Rebecca Grant describes the debates as being centered around operational concepts as well as roles and missions. She argues that the unfolding debate is not unlike similar debates on these same concepts between the services over the years since the creation of an independent Air Force in 1947.[3]

Within the Air Force, the natural fit for the MQ-1 into the armed reconnaissance role is not seamless. The way ISR and ground attack assets are doctrinally resourced, tasked and flown

in support of requirements are at odds with each other. Between the services, the mission of fixed-wing reconnaissance and ground attack creates a debate over traditional roles and missions. Additionally, the command and control structure of the Theater Air Control System/Army Air-Ground System (TACS/AAGS) is not optimized to support the integration of UAV operations required in tomorrow's battlespace.

The purpose of this paper is to examine the issues of weaponized UAV integration into the future battlespace from the standpoint of doctrine, operational concepts and roles and missions and to make recommendations on how best to employ this capability in the future. The next chapter will provide background information on the evolution and employment of weaponized UAVs as well as review relevant joint and service doctrine. Chapter 3 will analyze the issues associated with command and control of weaponized UAVs, discuss the service programs and points of view, and look at emerging doctrine. Chapter 4 will provide recommendations based on the current issues, followed by conclusions.

For the purposes of this paper, the discussion will be limited to currently fielded or soon to be fielded weaponized UAVs, specifically the MQ-1/MQ-9, the ER/MP Warrior UAS and to a lesser extent the RQ-5 Hunter. This paper is slightly technical in nature and is directed towards an audience familiar and concerned with multi-service doctrine for air-to-ground command and control, joint firepower integration and UAVs. From this point forward, the term unmanned aircraft (UA) will be used to describe a single UAV and unmanned aircraft system (UAS) will be used to describe the aircraft and its associated command and control equipment that make up the system as adopted by the 2005 Department of Defense UAS Roadmap.

Chapter 2

Background

This chapter provides background information on the USAF Predator and US Army Warrior programs. It briefly covers the development of the UAs and then discusses doctrine for requesting and tasking reconnaissance and close air support.

Unmanned Aircraft

UAs are defined by the Department of Defense (DOD) as a powered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload.[4] UAs have been around for years and were used in Vietnam (AQM-34 Firebee) but did not gain favor as a tactical intelligence platform until the Israelis demonstrated UA effectiveness with the Pioneer in Lebanon in 1982. Acquired by the U.S. Navy from Israel, the Pioneer proved its worth at the tactical level during Desert Storm and its demonstrated ability opened up new UA research and development that led to the USAF Predator.[5] The Predator saw its operational debut in the Bosnia in 1995 and came to the forefront of aviation news during Operation Allied Force in 1999.[6] The weaponized Predator was first employed in combat during Operation Enduring Freedom in Afghanistan and its use for air to surface attack in Iraq is now common place. In another Predator first, an aircraft armed with a Stinger air-to-air missile unsuccessfully attempted to engage a MiG-25 over the Southern Iraq No Fly Zone in December 2002.[7]

USAF Predator

The Predator ACTD started in 1994 and transitioned to the USAF in 1997. The Predator, built by General Atomics, has a 48.7 foot wingspan, is 27 feet long and typically cruises at about 80 miles per hour. Its inverted V tail protects the pusher propeller during take-offs and landings.[8] Typical operating altitudes for the Predator are between 10,000 and 15,000 feet MSL, but it has the capability to fly at altitudes up to 25,000 feet. The MQ-1 has two hard points which are typically used to carry a pair of AGM-114 Hellfire missiles. The larger version of the Predator, the MQ-9 Predator B now called the Reaper, can operate at altitudes above 45,000 feet and has six hard points allowing it to carry up to ten AGM-114 Hellfire missiles or four 500 pound-class precision weapons.[9] Depending on the mission profile, the MQ-1 can stay on station as long as 24 hours but typical sorties in SW Asia provide 14 hours station time. The older Predator versions carried two electro-optical (EO) and infrared (IR) sensors while the most recent variants include a laser designator capable of designating targets for attack or guiding laser-guided munitions. A synthetic aperture radar (SAR) payload is also available for the MQ-1 which allows the system to see through weather and clouds but the installation prevents the carriage of missiles.[10] A SAR payload will be standard on the MQ-9 Reaper.[11]

Air Force Organizations

The Air Force designed the Predator system to be operated beyond line of sight from its ground control station (GCS) which requires the use of satellite communications for aircraft control. A local, line-of-sight GCS is responsible for takeoffs and landings and once successfully airborne control is switched to another GCS located outside of theater for control of the mission.[12] At Nellis Air Force Base (AFB) the Air Force uses rated pilots to fly the Predator and sensor operators to control what the sensors are looking at, all through a KU band satellite

link.[13] Currently there are three Air Combat Command Predator squadrons, the 11th, 15th, and 17th Reconnaissance Squadrons all based at Creech AFB in Indian Springs, Nevada. The Air Force Special Operations Command also has the 3rd Special Operations Squadron flying the MQ-1[14] and the Air National Guard is transitioning some of their units to UAs, having already started converting the 163rd Air Refueling Wing at March AFB to the MQ-1.[15] In November 2006, the USAF stood up the first MQ-9 squadron at Creech and designated it the 42nd Attack Squadron. The USAF plans to buy some 170 MQ-1s by 2010 as well as between 50 and 70 MQ-9s by 2012 to outfit approximately 15 squadrons for a total of over 220 additional UAs.[16]

Operational Use

Although first deployed to provide intelligence gathering for NATO efforts in Bosnia, the Predator demonstrated its potential in Kosovo supporting Operation Allied Force. Video feeds from the Predator were data-linked to the Combined Air Operations Center (CAOC) and to other command headquarters and for the first time provided real-time video feeds of major air combat operations.[17] Several Predators were claimed to have been shot down by Serbian Forces (need source ref here) while others have been lost to icing and technical malfunctions such as loss of the command and control data link signal. Despite these early issues, Predators were deployed to central Asia shortly after September 11, 2001 and have been in continuous operations to support combat operations across the entire theater and have been singled out by operational commanders as vital to their mission.[18]

Recent developments allow video sharing between aircraft and ground personnel. The Remote Operations Video-Enhanced Receiver (ROVER) can receive video feeds from several types of UAs through a multi-band antenna, allowing an operator such as a Joint Terminal Attack Controller (JTAC) to view the video real-time on the ground while supporting ground operations

and directing air strikes. The ROVER is being fielded as standard equipment for USAF JTACs serving in Iraq and Afghanistan. There are 245 ROVER kits in theater for USAF JTACs alone, with SOCOM and other organizations fielding kits to outfit their forces as well.[19]

US Army Warrior

The mainstay of the division and corps level reconnaissance systems has been the RQ-5 Hunter built by Northrop-Grumman. Although full scale procurement was halted in 1996 with only seven systems of eight aircraft each, 18 more aircraft were purchased in 2004. The Hunter has been employed in the Balkans as well as in Iraq for Operation Iraqi Freedom.[20] The Hunter has an EO/IR sensor payload for day and night operations and can fly at altitudes up to 25,000 feet for up to 12 hours.[21] In 2004 the Army deployed a weaponized version of the Hunter, the MQ-5 to Iraq along with the Viper Strike munition and soon all versions will carry the weapon. The Viper Strike is a laser-guided, glide munition capable of using Global Positioning System (GPS)-aided navigation with a semi-active laser seeker for terminal guidance. The weapon uses a four pound High-Explosive, Anti-Tank (HEAT) warhead for top-down attack which helps to minimize collateral damage.[22] Test of the Viper Strike went very well with seven out of nine direct hits during one testing phase.[23] Combat results have yet to be released in a public forum.

The discontinuation of the Hunter program and the cancellation of the RAH-66 Comanche helicopter drove the Army's interest to the ER/MP UA. In response to the 1990 Joint Requirements Oversight Council (JROC) endorsement of the Mission Need Statement (MNS) for a long endurance reconnaissance, surveillance and target acquisition (RSTA) capability, the Army produced an Operational Requirements Document (ORD) to re-emphasize the MNS and to outline how the ER/MP program would satisfy Army requirements still unmet for RSTA. [24]

With the ORD in hand, the Army moved forward with a competitive process and in August 2005 awarded General Atomics the ER/MP contract to build the Warrior System.

Predator Comparison

The Warrior UA is very similar to the Predator yet slightly larger with a 56 foot wingspan and 28 foot length. (see Figure 1 for comparisons with the MQ-5 Hunter) It carries a similar payload and can carry four AGM-114s externally. The major difference from the Predator is the heavy-fuel engine that will allow it to burn JP-8 making fuel resupply common with almost all Army vehicles. Where the Air Force uses rated pilots to fly the Predator, Army Aviation will use enlisted operators to operate the 11 systems with 12 UAs per system. Included with the UAS is the One-System Ground Control Station (OSGCS) which will allow a single, common "cockpit" design to control the entire span of UAs the Army will operate. Units in the field will be able to link to Warrior (and other UAs) video using the One System Remote Video Transceiver (OSRVT) which is a ROVER terminal on steroids that gives the operator more situational awareness on the UA position and attitude by using a Falcon View map software overlay.[25]

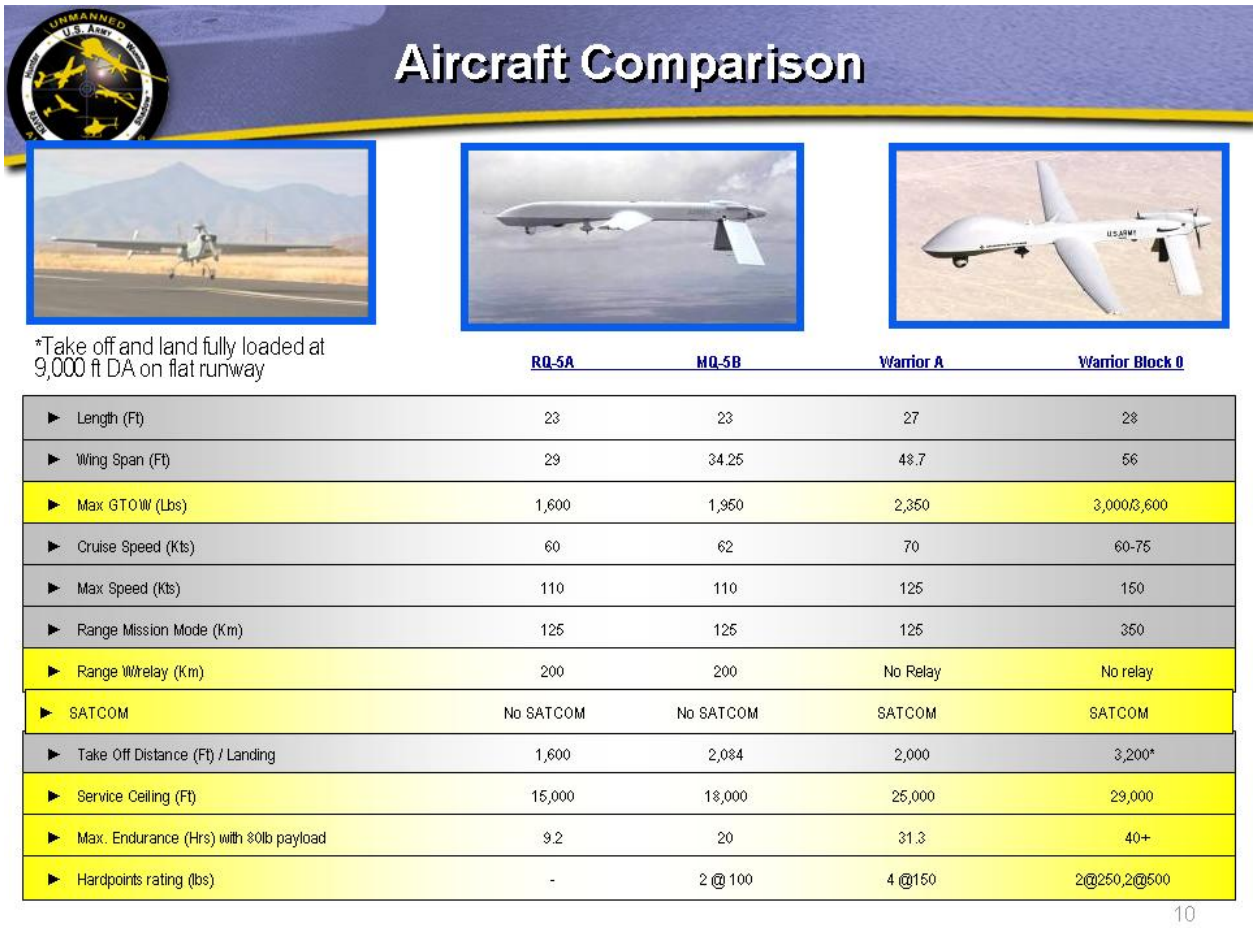

Figure 1: UAV Aircraft Comparison[26]

USAF Doctrine for ISR Tasking

Most theater ISR requests are coordinated through the ISR Division (ISRD) of the Air and Space Operations Center (AOC). Typically the ISRD consists of several teams that correlate and fuse intelligence, manage ISR operations and prioritize requests for information/intelligence (RFIs).[27] Planning for ISR operations starts when requirements are established, validated, and prioritized. The collection manager aligns these requirements with platforms and sensor capabilities, first coordinating with planners to determine if organic platforms can handle the mission.[28] These ISR requirements, as stated earlier, are prioritized into the ISR sensor collection "deck" and are tasked by the ISRD for airborne platform collection through the Air

Tasking Order (ATO).[29] Innovation as the result of increases in technology has led to tasking manned multi-role platforms like fighters with targeting pods as non-traditional ISR (NTISR) collectors while traditional ISR-only unmanned platforms like the Predator have now been tasked to perform strike operations. In these cases, mission priorities for the aircraft, sensor employment and authority-to-task must be clear and pre-coordinated.[30] This doctrine can cause tasking conflicts and will be addressed in later chapters.

Joint Doctrine for TACS/AAGS

The tasking process for command and control of close air support (CAS) of ground forces has evolved over many years since first practiced in Europe in 1944. The Theater Air Control System is the Combined Force Air Component Commander's (CFACC) mechanism for tasking and controlling air and space power to support the needs of the ground forces. The TACS allows the CFACC and his CAOC to centrally plan and control airpower while the subordinate levels of the TACS network are responsible for decentralized execution.[31] These are the basic tenants of airpower employment and are the fundamental organizing principles for air and space power.[32]

The basic element of the TACS consists of the Tactical Air Control Party which is made up of Air Liaison Officers (ALOs) and Enlisted Terminal Attack Controllers (ETACs). The TACP is aligned with Army maneuver units from battalion through corps with the principle purpose of advising on the capabilities and limitations of airpower and assisting in the planning, integration, request and control of airpower.[33] At the corps, the Air Support Operations Center (ASOC) processes immediate requests for CAS and is responsible for coordination and control of missions in its assigned sector as well as assisting time-sensitive-targeting (TST).[34] All elements of the TACS can communicate via multiple nets and means including the Joint Air Request Net (JARN) and the Tactical Air Direction Net (TADN).[35]

Employment

The Army Air-Ground System is closely related to and interconnected with the TACS. At all levels the Army Airspace Command and Control (A2C2) element coordinates Army Aviation integration and deconflicts fire support requests with the fires cell and the TACP. Requests for pre-planned air support are sent through Army operations channels to the Battlefield Coordination Detachment (BCD) which is co-located with the CAOC.[36] Together the network is called the TACS-AAGS and is the system for requesting and controlling airpower in direct support of ground forces. (see Figure 2). The solid lines in Figure 2 depict the traditional command and control communication relationships between elements of the TACS-AAGS while the dashed lines depict alternate communication links between the ground and airborne elements of the system.

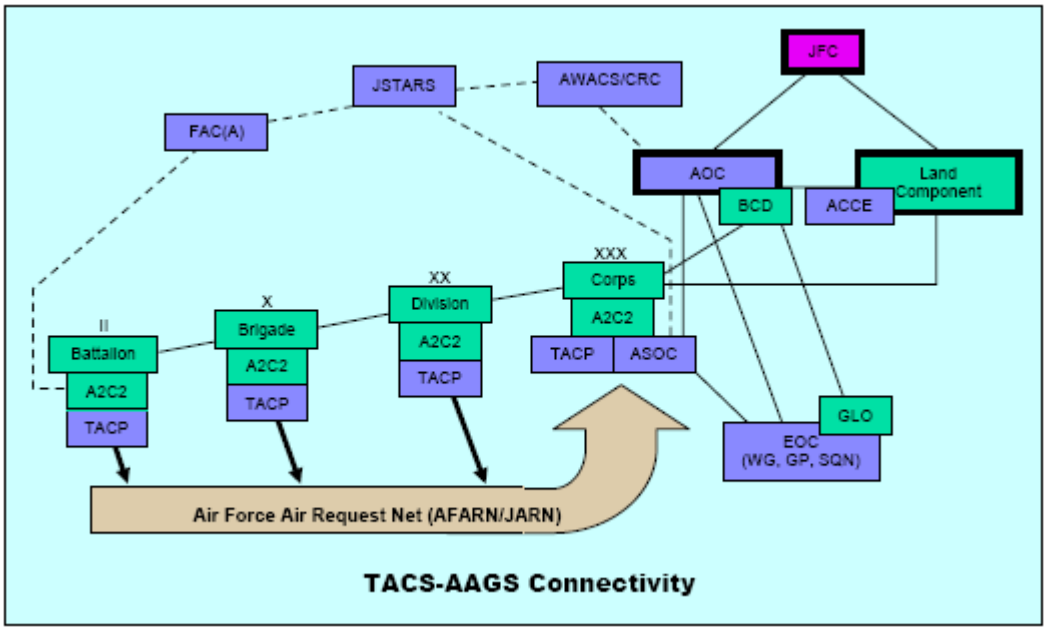

Figure 2: Key Air Force and Army Components of the TACS-AAGS[37]

A key term needed to discuss airspace deconfliction between fixed wing and rotary wing is the coordinating altitude. The coordinating altitude is a procedural measure (altitude restriction)

that separates the blocks of airspace in which fixed wing and rotary wing aircraft operate.[38] Many organic Army UAVs operate below the coordinating altitude as a method of deconfliction from fixed wing aviation.

Chapter 3

Doctrinal and Mission Issues

The previous chapter provided background information on Air Force and Army weaponized UAs and how the USAF tasks the Predator for employment. This chapter will discuss the command, control and service program issues as well as doctrinal and employment issues associated with Air Force and Army weaponized UAs. It will explore the disconnects in the process used by the USAF to task and employ the MQ-1 Predator, address the Army's effort to procure the Warrior in spite of a roles and missions debate over this mission area, and finish with a discussion of some doctrinal differences between the Air Force and Army on terminal control, tasking, and overall command and control. There are fundamental differences between the Air Force and the Army on direct support and ownership of UAs and without serious dialogue and compromise the end state could be a crowded airspace with redundant capability.

USAF Predator Employment

Doctrinal Issues

Issues concerning the use of the RQ-1 for ISR-only were challenged when General John Jumper, former Chief of Staff of the Air Force, directed the integration of a laser designator in time for operations in Kosovo that allowed the Predator to designate targets for attack by other aircraft. The USAF really started to realize the full potential of UAs for strike and not just ISR after the first Hellfire missile was test fired in 2001.[39] The debate still rages. Air National Guard

Brigadier General Stanley E. Clarke, deputy director for strategic planning for the Air Staff recently commented on the subject: "It's not clean-cut anymore. Predators fitted with Hellfires raise a very interesting question – are they strike or ISR [systems]?"[40]

Tasking Process

This issue is important because how the weaponized UAs are perceived (strike versus ISR) impacts the operational concept on how they are tasked and employed. Previously, RFIs were sent to the ISRD for processing and prioritization. These requests were prioritized in the ISR deck and sourced with a platform. The system works well for traditional imagery requests when multiple RFIs were serviced by one pass of the platform. In this case it made perfect sense to organize and prioritize the requests and then coordinate which asset will image the target. RFIs need to be into the network three days prior to the date flown, and depending on the type of imagery requested, it could be up to three days before the end user gets the final product.[41] To add insight to this discussion on how ISR doctrine is not optimized for weaponized UA employment, Major Clayton "Bags" Marshall provides these comments: "The current ATO cycle works great for a campaign against static targets. But in the current war, the 72 hour ATO cycle plus 20 hour sortie length means that the Predator target deck is obsolete by takeoff. Instead, Preds are given takeoff times and then parceled out to users in blocks of time for ad hoc target prosecution. [The] problem is that users have to compete for Pred time, so they put forward their most "pressing" requests in order to get slated for Pred time in the first place. When they actually succeed in getting support, they usually throw out their outdated request[s] and start from scratch with new, up-to-the-minute targets."[42]

The value of the Predator is its long dwell time and full motion video (FMV) capability. Ground commanders immediately saw the value of Predator as a way to gain battlespace

awareness and for battle tracking. The big question now for ground forces was "how do I request an armed Predator?" Often times Army units in Iraq or Afghanistan turn intelligence tips into operations in a matter of hours and for special action units in a matter of minutes.

Requesting an MQ-1 three days out for an event that has yet to materialize is not an effective way to use the Predator. Pulling the MQ-1 away from its deck tasking is no easy task either. It is often easier to task a CAS asset through the ASOC to support a short-notice operation than it is to prove to the ISRD that the raid in progress is higher priority than servicing the ISR deck. What is required for the mission is an asset with long dwell time and video downlink for the ground commander's situational awareness. The ability to quickly target the same objective from the same platform is the effectiveness of the weaponized UAV. If more firepower is required, the JTAC can closely coordinate with the sensor operator to mark targets for other airborne strike assets. The fighters themselves are often equipped with ROVER downlink capability, but they frequently have to leave station to go to the tanker and have to play catch up once back to get re-acquainted to the tactical situation.

FMV is most useful for the ground commander and operators involved in the current, ongoing mission/operation. FMV is of less value as a data source because it is not mensurated or cannot be ortho-rectified. Coordinate mensuration, also called ortho-rectification, is the process where aerial photographs are registered to a map coordinate system and potential measurement errors are removed for obtaining precise coordinates.[43] RFIs requiring this type of imagery are best left to the traditional ISR platforms, but because of the lack of total ISR assets on the battlefield in Iraq and Afghanistan, the MQ-1 often gets tagged with missions better suited for other platforms.

The dwell/stare time of UAs like the Predator is particularly useful for special operations forces (SOF) that are looking for patterns or chasing individuals. The quietness of some UAVs from a standoff perch will not "spook" or tip-off the suspect like the sound from a fast-moving fighter, an EP-3 or AC-130. Because of these characteristics, the MQ-1 is often the platform of choice for SOF, who often times have priority for the asset over conventional ground forces. With not enough MQ-1s, data-link frequencies and GCS-controlled orbits to go around, the conventional ground units are often left with their organic UAs or fixed wing NTISR which may or may not have ROVER down-link and is often not the ideal platform for the tactical situation.

Roles and Missions

Army Employment

Because of the gap in requirements for ISR that the Army currently faces in Southwest Asia, the Army put forth the UAS ORD as previously discussed. The utility of UAs have driven an increase in Army procurement of UASs to fill this gap. The Warrior UAS program will add 121 vehicles to Army aviation. The entire program is expected to run approximately $1 billion.[44] By FY11, the Army intended to grow to 230 UAV units comprised of approximately 2331 systems and 7085 air platforms of all types.[45] Recent adjustments, however, based on budgetary constraints and joint-force requirements mean that the numbers of UAs fielded will not be as robust as this as two classes of mid-sized UAs for the future combat system will not be developed.[46] Weaponized, fixed-wing Army UAs, operating at altitudes up to 25,000 feet got the attention of many in the Air Force.

Roles and missions discussions between the services have been ongoing periodically since the inception of the Air Force as a separate service. The debate over the role of Army aviation in the 1960s led to the agreement that Army aviation would be strictly limited to support of ground

troops and would not encroach on traditional USAF roles such as interdiction or CAS. This agreement between the Army and Air Force Chiefs of Staff in 1966 that authorized the development of attack aviation was amended in 1975 to clarify that the attack helicopter did not provide close air support.[47] The most recent guidance on roles and missions of the services is found in DOD Directive 5100.1, *Functions of the Department of Defense and Its Major Components*, 1 August 2002, which states it is the responsibility of the US Air Force to "…organize, train and equip and provide forces for close air support and air logistic support to the Army and other forces, as directed, including airlift, air and space support, resupply of airborne operations, aerial photography, tactical air reconnaissance and air interdiction…".[48] It further states that the Air Force is responsible for providing aerial imagery as well.[49]

Debate

Some argue from the DOD directive standpoint that fixed-wing weapons delivery in this case is strictly an Air Force mission. Others similarly argue that air breathing ISR platforms operating at altitudes above the coordinating altitude in support of ground operations is also an Air Force mission. On the contrary, it is easy to see that from an Army aviation point of view, UA-delivered AGM-114 is really no different than an AH-64 Apache shooting at a ground target with one. In a similar logic, the Army has been operating the Hunter for years at altitudes above the coordinating altitude with few issues.

Terminal Control

Closely associated with the roles and missions discussion is the issue of terminal control of weapons released from platforms providing CAS. Terminal control is the authority to direct aircraft to maneuver into a position to deliver ordnance.[50] CAS requires detailed integration of each air mission supporting ground forces because of the close proximity of friendly forces to the

target to avoid fratricide and get the desired effects on the target.[51] The Air Force supports Army maneuver units with JTACs and Forward Air Controllers (Airborne) (FAC (A)) to provide this detailed integration for CAS as part of TACS. The JTAC on the ground directs CAS in support of the ground commander's intent for battlefield effects and links the CAS pilot who may be previously unfamiliar with the ground situation to the battle by providing the situational awareness of target and friendly locations. JTACs and FAC (A)s are the only personnel trained and authorized to provide terminal control of CAS on the battlefield. The Air Force doctrinally likes to see Airmen control Airpower. The Army recently established the requirement for some JTACs down to the company level due to the changing nature of the non-linear battlefield and endorsed the JTAC Memorandum of Agreement (MOA) that set JTAC standards across the services.[52] Understanding the unique JTAC training requirements that limit production numbers, the Army and Air Force along with the Special Operations Command (SOCOM) established the Joint Fires Observer program that would produce advanced forward observers, capable of conducting surface-to-surface fires and providing targeting support to JTACs.[53] The JFO will use technology such as the ROVER to act as a sensor for the JTAC who will have over-all positive control over weapons release from CAS platforms.

Employment Disconnects

The issue of terminal control for a weaponized UA blurs when it comes to cross-service ideas on the employment of joint fires and CAS. The Air Force approaches the concept of a Predator-delivered Hellfire in support of ground forces as CAS, and that requires a JTAC or FAC (A) somewhere in the loop to clear fires and ensure deconfliction. The *Multi-Service Tactics, Techniques, and Procedures for the Tactical Employment of Unmanned Aircraft Systems* publication by the Air Land Sea Application Center provides a great discussion in Chapter IV on

how the JTAC and UAS can fit together in a CAS employment scenario.[54] In the way the Army fights today, a forward observer (FO), not even JFO or JTAC-qualified, can conduct an attack aviation call-for-fire with an AH-64 armed with AGM-114.

Table 1: Types of CAS Terminal Attack Control

Type of CAS Final Control	JTAC Actions	Remarks
Type 1	JTAC must visually acquire the attacking aircraft and the target for each attack.	Attacking aircraft geometry is required to reduce the risk of the attack affecting friendly forces.
Type 2	JTAC requires control of individual attacks and any or all of the following conditions: • JTAC is unable to visually acquire the attacking aircraft at weapons release. • JTAC is unable to visually acquire the target. • The attacking aircraft is unable to acquire the mark/target prior to weapons release.	Applicable scenarios are night, adverse weather, and high altitude or standoff weapons employment. Successful attacks depend on timely and accurate targeting data that may be provided by another source (e.g., scout, COLT, FIST, UAV, SOF, or other assets with accurate real time targeting information).
Type 3	JTAC requires the ability to provide clearance for multiple attacks within a single engagement subject to specific attack restrictions.	Type 3 control does not require the JTAC to visually acquire the aircraft or the target; however, all targeting data must be coordinated through the supported commander's battle staff.

Source: Joint Publication 3-09.3, *Joint Tactics, Techniques and Procedures for Close Air Support*, 3 September 2003, Incorporating Change 1, 2 September 2005, V-14 – V-19.

Table 1 above is taken from JP 3-09.3 and provides a brief synopsis of the types CAS terminal attack control. The JTAC will usually control a UA using Type 2 CAS procedures. The concern with a UA-delivered AGM-114 is magnified because the FO/JFO or JTAC will probably not see the platform as in Type 2 or 3 final control, and without ROVER or OSRVT, will have to resort to basic CAS talk-on and deconfliction procedures; training and certification in this case are a must. The Air Force mitigates this sort of risk by having rated pilots flying the MQ-1 and a JTAC/FAC (A) performing the final control. With the Army, the Warrior could potentially be employed by a distant crew supporting an FO on the ground without a ROVER/OSRVT feed or JTAC in loop. This situation will present significant operational challenges without proper future consideration of CAS doctrine and procedures for UA employment. The complexity concerning the delivery and deconfliction of freefall weapons exacerbates the issue of terminal control by non-JTACs. Should the Warrior Block 0 be outfitted for GBU-12 laser guided bombs

or the Small Diameter Bomb (SDB), there will be serious roles and missions debates in addition to ones ongoing. Is the Army developing a fixed wing CAS and interdiction capability that is redundant to the missions and systems that the USAF provides?

Army Direct Support Doctrine

Each Army division will eventually get its own organic Warrior system. While this will help alleviate UA requirements for the divisions, it could lead to ineffective use of a very capable asset. The ER/MP mission profiles/missions will include RSTA, communications relay, chemical, biological and nuclear detection, critical logistics delivery, air-to-ground targeting and potentially air-to-air targeting.[55] The number of diverse missions and varied requests for support across the battlefield could quickly lead to confusion and ineffective UA employment as ground units and even divisions fight for control of the asset for their mission requirements. The Army Air Corps in North Africa in 1943 quickly learned that attaching fighter units to specific ground units was an ineffective way to employ airpower across the entire spectrum of the battlefield. Out of this confusion was born the airpower tenant of centralized control, decentralized execution as a way to focus the specific effects of airpower at the right place and time on the battlefield. General Eisenhower stated in dispatches following the North African Campaign that: "Direct support of ground troops is naturally the method preferred by the immediate military commander concerned," but his vision did not extend beyond the local battle. It did not consider "the competing demands of individual commanders on a far-flung battlefront, each of whom would naturally like to have at his disposal some segment of the Air Force for his own exclusive use."[56]

The Army's answer to limited support from low density, high demand theater assets as well as gaps in Corps-level Hunter coverage was to procure the Warrior. The ER/MP ORD citied an

Air Combat Command White Paper dated 13 April 2004, which stated "…the Air Force has been unable to service every request in the past due to limited assets…".[57] Is organic ownership of a weaponized UA the right answer to past lack of assets? Will organic ownership lead to ineffective or inefficient UA employment across the battlespace? These are the questions that future doctrine will have to address to ensure the right mix and proper employment of weaponized UAs.

Grant hits the issue on the nose in "Clash of the UAV Tribes" where she states "For the future, it all comes down to where to place the limits on organic UAVs and how to ensure that all UAV systems are netted into a central battlespace information architecture."[58] The system will be in place for potential centralized control, decentralized execution of Army-operated UASs. The OSGCS is designed with a common cockpit so control of platforms can be switched from unit to unit across the battlefield, allowing individual users to take control for their specific mission then pass it back to the division.[59] The TACS-AAGS network exists to allow UA requests to be prioritized and platforms distributed. The Army is already discussing manned-unmanned teaming to decrease sensor-to-shooter delays.[60]

The way the Army approaches attack aviation support to ground units is changing. In Iraq, AH-64s are providing convoy escort and quick-reaction for troops-in-contact (TIC) situations. They are teaming with JTACs, fixed wing CAS, MQ-1s and other UAs to find, fix and finish insurgents who can be found in a range of situations from improvised-explosive device (IED) planting, ambush operations, and setting indirect attacks with mortars and rockets. This new-style approach to ground operations is not called CAS but direct support. Whatever it is called, it is an example of what can be accomplished with joint integration. Organic ownership may not be the right answer for UA employment unless a better way to control assets in near-real-time

can be accomplished. In an example of why legacy Army Airspace Command and Control (A2C2) procedures are not adequate for tomorrow's battlespace, the 4th Infantry Division's (4 ID) foresaw the need to change from older ways of C2 to a near real time coordination during their recent deployment to Baghdad for Operation Iraqi Freedom. This need was driven by the aircraft density and airspace complexity over Baghdad.[61] These issues will be further discussed in the following section.

TACS-AAGS Shortcomings

The TACS-AAGS system has served the Army and Air Force well over the years but is not optimized for the future battlefield. The coordinating altitude used to be 200 feet in Europe during the Cold War and now due to increased low altitude activity in Iraq it is 3000 feet.[62] "The ground is rising," said Brig Gen Michael Longoria, formerly of the Joint Air-Ground Combat Division (JAGD) at Langley Air Force Base, Virginia. He further related that JAGD has heard of requests for block airspace up to 10,000 feet.[63] The C2 of airspace to support Army aviation is typically done by procedural control, which means that established procedures, routes and fire support coordination measures (FSCM) are in effect and followed by aircrews and UA operators alike.[64] Blocks of airspace and routes are set aside to ensure deconfliction from other assets in the airspace. This will be a particular problem for the battlefield of the future because it is difficult to clear entire volumes of airspace to deliver fires, particularly for assets like the Guided Multiple Launch Rocket System (GMLRS). This is an additional problem for prolific numbers of UAs operating in support of multiple units spread across the battlespace. Under the current construct, airspace control measures (ACM) such as Restricted Operating Zones (ROZ) are established to support UA operations. The number of ROZs required to support all of the UAs expected on the future battlefield will clog the airspace and constrain fires deconfliction.

Currently there is no DoD guidance on how many aircraft can be effectively managed in a particular section of airspace. The Center for Army Lessons Learned (CALL) captured the issue well in a recent report from a trip to Southwest Asia: "ACMs such as ROZs do not integrate airspace users…Because airspace is a finite resource, as the number of airspace users increases, AC2 elements run out of airspace."[65]

At Army units from battalion through corps, soldiers and Airmen are wrestling with these issues and how best to integrate operations for more effective and efficient operations. The Fire Support Cell (FSC) is a step in the right direction to integrate fire support activities and fires deconfliction. The ASOC until recently existed only at corps level but may now be included at division level and at the Multi-National Corps, Iraq (MNC-I) operates well as part of the FSC. The A2C2 cell at all levels of the TACS-AAGS system is not truly integrated. They coordinate procedures for input into the Airspace Control Plan (ACP) and Airspace Control Order (ACO) and ensure proper inputs to the Airspace Tasking Order (ATO), but typically do not positively control day to day Army aviation operations. Positive control is where aircraft are positively tracked by electronic means and communication and are provided direction and deconfliction.[66] The 4 ID A2C2 cell saw the need to control airspace below the coordinating altitude over Baghdad. Procedural control in this situation was inadequate, so they created their own form of near-real-time control by mixing positive control with procedural control and cobbling together a low-altitude air picture with feeds from air defense radars. The situation was not perfect but was a vast improvement and allowed a more effective and efficient use of the airspace by multiple users. The 4 ID is one of the first units to deploy to Iraq with the personal and resources to accomplish this task – there is no Army doctrine for the Army to control airspace.[67] The ASOC through and with the Control and Reporting Center (CRC) provides positive control for aircraft

operating in CFACC airspace above the coordinating altitude.[68] The airspace of the future will have to be integrated for effective employment of all assets in the battlespace to reduce sensor-to-shooter delays and integrate joint fires from multiple assets, be they fixed wing fighters, rotary wing attack aviation, GMLRS or UAs.

Chapter 4

Recommendations

Previous chapters covered background material on UAs as well as discussed the disconnects in the way the USAF tasks UAs, the debates over roles and missions between the services, and the issues concerning the command and control of UAs across a crowded battlespace. There are significant rifts between the Air Force and the Army in the way each service approaches these issues. This chapter will discuss recommendations to fix these issues that both the Air Force and Army can do to optimize the employment of weaponized UAs in support of ground forces. To gain the maximum capability from systems like the Warrior and Predator, both services will have to address doctrinal, roles and missions, and operational issues listed in this section that are not unique to one service.

Treat the MQ-1 like CAS

The MQ-1 or Warrior UA is best suited to be apportioned like CAS. At a recent speech, US Air Forces in Europe commander General William T. Hobbins said: "We need for unmanned aircraft to act like manned aircraft. We need unmanned aircraft to be tasked like manned aircraft. We need unmanned aircraft to fly in strike packages with manned aircraft."[69] Full motion video is most useful to the ground commander in real time. There are theater level requirements for long dwell/stare FMV, but those can be prioritized just like CAS requests are. When fighters are directed to a troops-in-contact situation, they can be pulled at any time to support a higher tasking. Likewise, they are available to support NTISR taskings when not

requested to support ground operations. The MQ-1 and future weaponized UAs can be tasked in the same manner. Since FMV cannot be mensurated, its value to future targeting is limited. UAs are best employed in finding the target and can either self-designate the target or another cell such as the ISRD or a JTAC using a program called the Precision Strike Suite for Special Operations Forces (PSS-SOF) can pull mensurated or "sweetened" coordinates for PGM engagement.[70] The ISR deck should be serviced by traditional assets such as F-16s with the TARS reconnaissance pod which can be mensurated or downlinked to a ground station, or Global Hawk which is more suited for theater-level ISR.

The method for requesting the MQ-1 is optimized for intelligence gathering but not for ground forces. The ISR request system is great for national or theater level assets but not effective to support a dynamic tactical battlefield. Request for UA support is treated like ISR and is handled via a DD Form 1975 which is similar to the form used for CAS requests. The TACS-AAGS system is designed to handle CAS requests and can handle tactical ISR requests in the same manner, but the breakdown occurs at the CAOC. The ISRD and the senior intelligence duty officer decide courses of action based on intelligence gain/loss. It is almost like centralized control, centralized execution and the explanation of dynamic retasking in the UAS Multi-Service Tactics Techniques and Procedures publication is confusing.[71] All the requestor wants is the ability to watch their ground action in real time and prosecute targets as they emerge. There is less intelligence gathering vice battle tracking. The dwell time of UAs makes them attractive to cover drawn-out ground missions over NTISR-providing fighters. The Army understands the utility of FMV to the ground commander hence their push to accelerate and increase the number of UAs supporting ground units currently in Iraq.[72]

Give the Weaponized UA Mission to the USAF

Weaponized, fixed wing ISR support to ground forces, able to operate at altitudes up to 25,000 feet is clearly an Air Force mission as outlined in DOD Directive 5100.1, *Functions of the Department of Defense and its Major Components*. Paragraph 6.6.3.2.5.states that it is the USAF's function "To organize, train, equip, and provide forces for close air support and air logistic support to the Army and other forces, as directed, including airlift, air and space support, resupply of airborne operations, aerial photography, tactical air reconnaissance, and air interdiction of enemy land forces and communications."[73] The Army's answer to the ISR gap and the lack FMV capability to support ballooning theater requirements is to buy their own platform. With cash in hand left over from the canceled Comanche program, they have executed the $1 billion Warrior UAS program. The Air Force is rapidly building MQ-1s and MQ-9 Reapers. Is this overkill based on requirements? Is this redundancy cost effective in a time of budget constraints? Obviously, the discussion on roles and missions for UA support to ground troops will have to happen.

Air Force Options

Based on issues outlined in this paper, it is recommended that the Air Force take over the mission of operating weaponized UAs. This could lead to a variety of options, some of which have already been proposed by the Air Force. An option would be to habitually align Predator squadrons with Army units similar to the way the Air Force supports ground units with TACPs, which could mean either USAF ownership outright or "Army buys, Air Force flies".[74] In conjunction to this proposal, the Air Force could station intelligence personnel with TACPs as ISR liaison officers (LNO) to Army units to assist in the employment of Predator and Reaper in

the fashion of centralized control, decentralized execution. This LNO could also help facilitate ISR requests as well as assist in tactical target coordinate mensuration for PGM engagement.

An agreement on roles and missions is not likely soon. Congressional language sponsored by Senator Richard Shelby of Alabama and signed into public law prohibits Tactical UAV program funds from being transferring from the Army and mandates that the Army retain responsibility for and operational control of the ER/MP UAS.[75] Even if the services cannot agree on UA roles and missions, there are many advantages to be gained by collaboration. Merging of the program, as suggested by the Quadrennial Defense Review (QDR) for joint warfighter acquisition programs through collaboration, could eliminate duplication of effort, cut redundant systems and ensure interoperability.[76] The QDR specifically addresses capability reviews to cut redundancies by assessing joint force capability portfolios.[77] The Warrior airframe, although only sharing 15% commonality with the Predator, has many positive attributes like the heavy-fuel engine and automated take-off and landing and is designed to operate in austere conditions.[78] Sharing the same manufacturer could lead to massive cost savings by merging the acquisition program because frankly, the Warrior is a better platform.[79] There are many features of the One System Ground Control Station and the One System Remote Video Transceiver that promise great utility and could make the system common/interoperable across the services if jointly procured.

If the services decide that the weaponized UA program should not be combined, both services still gain by participating in a Joint Center of Excellence (JCOE) as outlined by the Joint Requirements Oversight Council in June, 2005 and directed Chairman of the Joint Chiefs of Staff in November, 2005.[80] The Air Force has years of experience in UA operations and has led the way with the MQ-1. Some USAF Predator pilots come from fighter cockpits and bring a

wealth of weapons delivery knowledge to the community. This cross talk could mitigate some of the inexperience of Army UAS operators in the area of UA-delivered weapons. The Air Force could share the training pipeline for Warrior with the Army. A joint training program could ease the burden on USAF rated officers required to fill positions as UA pilots by leveraging Army-trained UAS operators for many portions of the training curriculum.

The Army should consider allowing their operators to get a Private Pilot, Single Engine Land rating and allow them to accrue flying hours towards an instrument rating (for which they get most of the academics in school). An instrument rating would help convince the Federal Aviation Administration (FAA) to allow UA operations in the National Airspace, among other see and avoid concerns, and would allow a tremendous increase in access to training areas and pave the way for routine border operations.[81] Currently, Predator operations in the National Airspace (in non-restricted airspace) are limited to case by case situations for transit-only above Flight Level 180 where positive control is required.[82]

Establish Joint Standards for UA Weapons Employment

The earlier discussion of terminal control highlighted the need for joint UA employment standards when it comes to UA-delivered weapons. Like the JTAC and JFO MOAs that establish training standards across the services, so too is required an inter-service training standard for weapons employment. It needs to be spelled out in detail and endorsed across the services exactly who can employ or conduct terminal control of an armed UA and what will be the training requirements.

Emerging tactics and procedures have not yet made it into the joint publications such as Joint Publication 3-09.3, *Joint Tactics, Techniques and Procedures for CAS* although the UAS JCOE has recently made a submission regarding the employment of UA in CAS.[83] The Air

Force has addressed terminal control of CAS by armed UAs in AFDD 2-1.3 *Counterland Operations* and this doctrine should be incorporated into joint doctrine immediately.[84]

Improve Joint Air-Ground Command and Control

Along with CAS terminal control doctrine for UAs, efforts need to be made for real-time or near-real-time command and control of all fires and tactical assets to effectively fight in tomorrow's battlespace. The TACS-AAGS is a stovepipe system that was fine for rapid management, planning and deconfliction on the Cold War-style battlefield but is not optimized to support real-time command and control.[85] It is not truly integrated even at corps-level yet will need to be in order to coordinate rapidly changing airspace to support the needs of the commander, especially with the planned multitudes of UAs and other assets. Emerging technology is leading to the real-time C2 of combat power with the advent of data-link and blue force tracker and IFF for UAs, in addition to systems like the Army's Tactical Air Integration System (TAIS) and the Air Force Link-16.[86] These types of systems and technologies will enable the A2C2 cell to move from procedural control to positive control. With all elements in the battlespace under some type of near-real-time control, the need for many static FSCMs goes away. In his article on Joint Air-Ground Control Cell (JAGC2), Curtis Neal proposes a JAGC2 cell that fuses all elements of various staff functions such as the ASOC, FSC, A2C2 and ISR into an organization focused on maximizing the effects of a single warfighting function.[87] (see Figure 3)

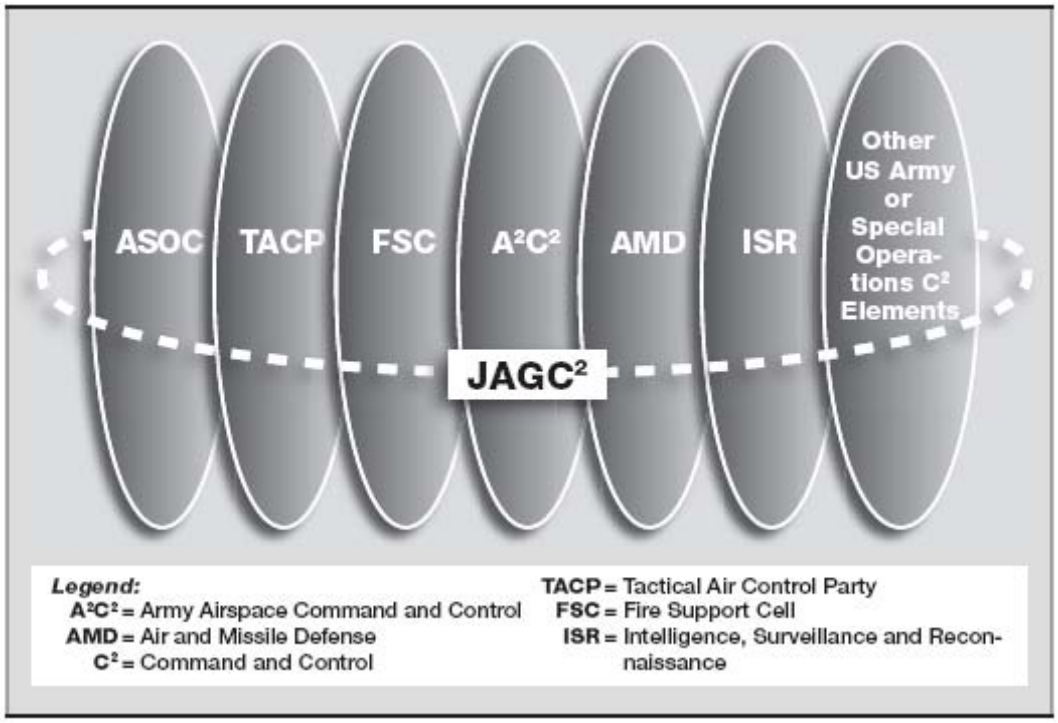

Figure 3: JAGC2 in the Division or Corps Main Command Post[88]

An element at division and corps like the JAGC2 is absolutely essential to maximize the effectiveness of armed UAs integrated with all other joint fires. Without the ability to deconflict fires real-time, UA operations will require blocks of airspace and ROZs that will hamper fixed and rotary wing integration and delay asset transfers between units. The JAGC2 will operate similar to the 4 ID AC2 cell example from Baghdad mentioned earlier in Chapter 3 on a grand scale. A JAGC2, digitally connected to all players who also have access to the Standard Integrated Air Picture (SIAP), will be able to maximize the effects of armed UAs teamed with other assets in real-time and is a perfect network for centralized control and decentralized execution of all air-delivered effects on the battlefield.

Chapter 5

Conclusion

The purpose of this paper was to examine the issues of weaponized UAV integration into the future battlespace from the standpoint of doctrine, operational concepts and roles and missions and to make recommendations on how best to employ this capability in the future. It started with a background discussion on the USAF Predator and the Army Warrior, how the USAF tasks ISR systems and then reviewed current doctrine that describes the air to ground command and control system for close air support. It then discussed the disconnects between the services on doctrine, operational concepts and roles and missions for UAs and followed with my recommendations on how to improve and optimize employment of weaponized UAs for close support of ground forces.

In review, what started as an ACTD has come a long way to the MQ-1 Predator, Warrior and Reaper of today, all armed and lethal. The demand for FMV and ISR in Afghanistan and Iraq has increased tenfold, yet the ability to match platforms with the requests led to gaps in coverage that were left unfilled or filled with fixed-wing NTISR. In an effort to cover the ISR/FMV gap, the Army bought its own organic UAS to field to divisions. The weaponized Warrior UAS crosses service lines into what is traditionally an Air Force mission. The Air Force had not planned to field the MQ-1 to the numbers the Army required due to funding, but made several proposals to take over the entire program as an Air Force mission (Army buys, USAF

flies). Currently, a QDR recommendation to merge the programs is delayed in staffing and the congressional language precludes the transfer of the program without an amendment.

Unless a decision is made soon on roles, missions, and numbers of UAs needed to support mission requirements, the Army and Air Force will have bought and fielded redundant systems with numbers in excess of battlefield requirements. My first two recommendations are to treat weaponized UAs like CAS and merge the Predator and Warrior program requirements. Merging the programs will gain cost savings and using the centralized control, decentralized execution tenant of airpower vice organic ownership can decrease the numbers required to support the mission effectively by sharing assets across the battlespace like CAS. This will require both services to thoroughly examine their ISR requirements as a collective joint portfolio as suggested in the QDR and establish firm acquisition numbers based on joint requirements.

Third, I recommend a joint acquisition strategy for interoperability, airframe and spare part commonality and cost savings. The USAF needs to terminate MQ-1 orders and buy the Army version of the ER/MP airframe immediately.

My fourth and fifth recommendations are to establish joint employment standards and to improve command and control. Both services must look at how they command and control weaponized UAs. The Air Force must follow the Army lead and get the MQ-1 and MQ-9 out of the old style ISR tasking channels and task them like fighter planes for CAS. The stand-up of the 42nd Attack Squadron with the MQ-9 Reaper is a step in the right direction and all Predator units should follow suit. Terminal UA control must be standardized across services for both UA operators and ground controllers. The TACS-AAGS system must be modernized along the lines of the JAGC2 to allow for near-real-time C2 and dynamic retasking of UAs to maximize employment and integration with other joint assets in the battlespace.

My final recommendation is to re-look at how we train UA operators. The Air Force should consider the Army model of enlisted or warrant UA operators to ease the stress on the rated force while the Army should consider the vast mid-size UA and weapons delivery experience that the Air Force has resident in its fighter and UA squadrons. Army UA operators need to have a private pilot's license and instrument rating that will not only provide an incentive to the enlisted force but also ease the transition for FAA approval to operate in the National Airspace.

A major shift in thinking is required to find ways to best integrate weaponized UAs into the fight. Technology and innovation rapidly make ideas into reality. Who would have thought that six years ago a test shot with an AGM-114 by an RQ-1 Predator would have led to major procurement programs of approximately $1 billion and Reapers armed with not only eight Hellfires but also two GBU-12s! Hate it or love it, "Joint" is the way ahead for UA procurement and employment.

Appendix A

Acronym List

AAGS	Army Air Ground System
ACM	Airspace Coordination Measures
ACO	Airspace Control Order
ACP	Airspace Control Plan
ACTD	Advanced Concept Technology Demonstration
AFB	Air Force Base
AFDD	Air Force Doctrine Document
AGM	Air – Ground Munition
ALO	Air Liaison Officer
AOC	Air Operations Center
ASOC	Air Support Operations Center
ATO	Air Tasking Order
A2C2	Army Airspace Command and Control
BCD	Battlefield Coordination Detachment
CALL	Center for Army Lessons Learned
CAOC	Combined Air Operations Center
CAS	Close Air Support
CFACC	Combined Forces Air Component Commander
CRC	Control and Reporting Center
DOD	Department of Defense
EO	Electro-Optical
ER/MP	Extended Range / Multiple Purpose
ETAC	Enlisted Terminal Attack Controller
FAA	Federal Aviation Administration
FAC(A)	Forward Air Controller (Airborne)
FMV	Full Motion Video
FO	Forward Observer
FSC	Fire Support Center
FSCM	Fire Support Coordination Measures

GCS	Ground Control Station
GMLRS	Guided Multiple Launch Rocket System
HEAT	High Explosive, Anti-Tank
IED	Improvised Explosive Device
IR	Infra Red
ISR	Intelligence, Surveillance and Reconnaissance
ISRD	Intelligence, Surveillance and Reconnaissance Division
JAGC2	Joint Air-Ground Command and Control
JAGD	Joint Air-Ground Division
JARN	Joint Air Request Network
JCOE	Joint Center of Excellence
JFO	Joint Fires Observer
JROC	Joint Requirements Oversight Council
JTAC	Joint Terminal Attack Controller
LNO	Liaison Officer
MOA	Memorandum of Agreement
MNC-I	Multi-National Corps, Iraq
MNS	Mission Needs Statement
NATO	North Atlantic Treaty Organization
NTISR	Non-traditional Intelligence, Surveillance and Reconnaissance
ORD	Operational Requirements Document
OSGCS	One System Ground Control Station
OSRVT	One System Remote Video Terminal
PSS-SOF	Precision Strike Suite for Special Operations Forces
PGM	Precision Guided Munitions
QDR	Quadrennial Defense Review
RFI	Request For Intelligence/Information
ROVER	Remotely Operated Video Enhanced Receiver
ROZ	Restricted Operating Zone
RSTA	Reconnaissance, Surveillance and Target Acquisition
SAR	Synthetic Aperture Radar
SIAP	Standard Integrated Air Picture
SDB	Small Diameter Bomb
SOCOM	Special Operations Command

SOF	Special Operations Forces
TACP	Tactical Air Control Party
TACS	Tactical Air Control System
TADN	Tactical Air Direction Net
TAIS	Tactical Air Integration System
TIC	Troops-in-Contact
TST	Time Sensitive Target
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
USAF	United States Air Force

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